Polyelectrolyte-Surfactant Complexes

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Polyelectrolyte-surfactant complexes (PSCs) are unique materials with the ability to spontaneously self-assemble into highly ordered superstructures on a nanometer length scale, showing a surprising extent of long-range order and symmetry as observed by small-angle x-ray scattering (SAXS).

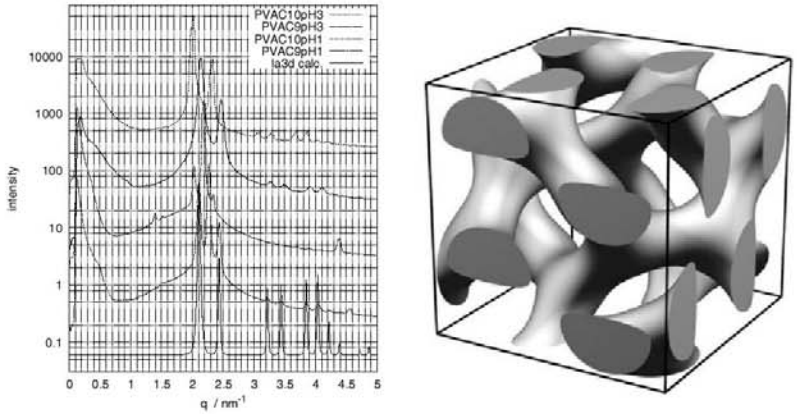

Figure 1: Experimental SAXS curves for PSCs formed between polyvinylamine hydrochloride (PVA) as the cationic polyelectrolyte component and sodium alkyl sulfates (C*n*) as the anionic surfactant at different pH, and calculated scattering curve for a Ia$\bar{3}$d "double gyroid" cubic morphology as shown in the 3D structure model on the right. The large number of observed SAXS orders leads to an unambiguous structure determination.

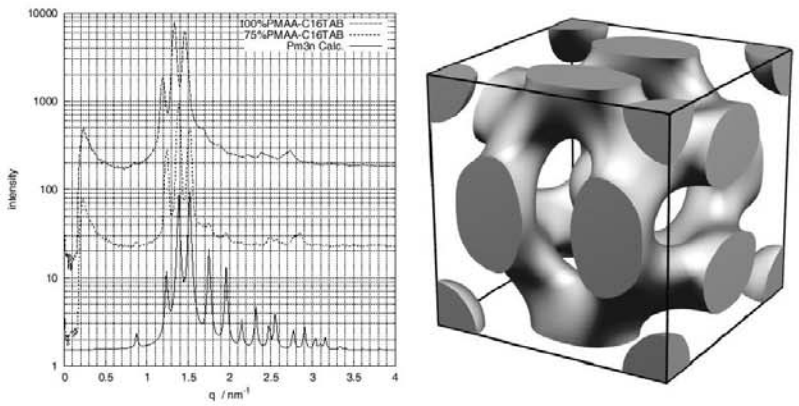

Figure 2: Experimental SAXS curves for PSCs formed between copolymer gels of methacrylic acid (MAA) and N-isopropylacrylamide (NIPAM) at varying charge densities as the anionic polyelectrolyte component and cetyltrimethylammonium bromide (C_{16}TAB) as the cationic surfactant, and calculated scattering curve for a Pm$\bar{3}$n cubic morphology as shown in the 3D structure model on the right.

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- Straightforward synthesis of PSCs: Superstructures are usually formed spontaneously upon pouring solutions containing the polyelectrolyte and the surfactant together.
- Small-angle x-ray scattering (SAXS) is an ideally suited technique for the nanoscale characterization of PSCs.
- Highly ordered superstructures are found for both water-free solid PSCs and for water-containing PSC gels. The degree of long-range order is usually higher in PSC gels since spatial constraints are easier to overcome in solution.
- Nanostructured solid PSCs can have potentially interesting technical applications due to their unique optical, electrical and mechanical properties.
- PSC gels can form model systems for biological processes since many important biological molecules are polyelectrolytes (DNA, proteins) or surfactants (lipids).
- PSCs with DNA as the polyelectrolyte could play an important role in gene therapy (transfection of hydrophilic DNA through hydrophobic cell membranes).